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(54) **SIZING APPARATUS**

KALIBIRIERSYSTEM

SYSTEME DE CALIBRAGE

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a sizing sleeve arrangement for controlling the outer diameter of a plastic tube being produced by a continuous tube forming process such as extrusion, or by an expansion process such as that generally described in WO-A-9002644, wherein the tube at least in the region of the sizing sleeve is under positive internal pressure.

[0002] It is known to provide sizing sleeves for tube diameter control with passages allowing the injection of lubricating water between the sleeve and the travelling tube, for example as achieved by a helical channel about the sleeve as described in WO-A-91 04 147 and EP-A2-0 385 285. In the case where the inside of the tube is not pressurised, these sizing sleeves may also have apertures in the sizing sleeve for applying a vacuum to the outside of the tube.

[0003] Document GB 1 154 259 discloses an apparatus for sizing and cooling a plastic extrudate in accordance with the preamble of appended claim 1, wherein the sleeve is axially segmented into high and low pressure portions, such that lubricating fluid supplied by the high pressure portion forms a layer between the sizing sleeve and the plastic extrudate and is drained at the low pressure portions.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide a sizing sleeve for controlling efficiently the outer diameter of an internally pressurized plastic tube. Therefore, the present invention provides a sizing sleeve according to appended claim 1.

[0005] Preferred embodiments of the sizing sleeve are defined in the dependent claims.

[0006] The solution proposed has the advantage that very fine injection apertures can be produced the size and shape of which can be carefully controlled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Further preferred embodiments will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a schematic longitudinal cross-section showing a first embodiment;

Fig. 2 is a similar view of a second embodiment; and

Fig. 3 is an elevation, partly in cross-section, of a modular sizing sleeve;

Fig. 4 is an end view of a segment of Fig. 4;

Fig. 5 is a detail of a groove cut into the end of the segment;

Fig. 6 is a partial end view of an alternative modular sizing sleeve;

Figs. 7A and 7B are part axial cross-sections taken along lines 7A-7A and 7B-7B respectively of Fig. 6;

Fig. 8 is a part axial cross-section of an entry arrangement for the sizing sleeve; and

Figs. 9 and 10 are axial views of a further embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0008] With reference to Fig. 1, the extruded tube 2 is formed to approximately the desired outside diameter, but requires calibration to ensure conformance to required specifications. While the material of the tube is still sufficiently plastic to be shaped, the tube approaches a sizing apparatus for fine control of the final outside diameter. In the context of the present invention the extruded tube is under positive internal pressure, thus pressing the tube against the cylindrical inner surface of the sizing apparatus. Cooling is applied to the extruded tube within and downstream of the sizing apparatus to lock in the final diameter.

[0009] The illustrated sizing sleeve means consists of a plurality of pressurised sizing sleeve portions 10 alternated with drainage zones 12. In the arrangement of Fig. 1, each drainage zone may be a small gap between adjacent pressurised portions 10 of the sizing sleeve means, allowing sufficient area for the water injected in the previous pressurised portion to escape and isolating adjacent pressurised portions but insufficient unsupported length to allow substantial outwards creep of the tube.

[0010] Each pressurised portion 10 is formed as a jacketed tube, the inner tube 14 being perforated with a large number of injection apertures 16. Cool water from a high pressure source 17 is introduced under pressure to the annular manifold space between the inner 14 and outer 18 tubes and is injected through the apertures 16 to form a fine layer of water which both lubricates the movement of the tube past the inner surface of the sizing sleeve and cools the outside of the tube to lock in the final tube diameter..

[0011] The sizing sleeve means is also adapted for the situation where the tube entering the sizing sleeve is not at its extruded diameter, but is instead being diametrically expanded in order to impart circumferential orientation of the polymer molecules. In the arrangements described in International Patent Application Nos. WO 90/02644 and PCT/AU94/00784, the tube is expanded by means internal fluid pressure restrained

by an inflatable plug. A sizing sleeve according to the invention may be located at the downstream limit of expansion of the tube in order to provide final diameter control of the expanded tube.

[0012] The separation of the pressurised portions 10 by drainage zones 12 allows the injected water from the upstream pressurised portion to escape, preventing build up of water between the tube and the sleeve inner surface, which can result in fluctuations in diameter of the resultant tube.

[0013] The drainage zones further allow isolation of pressure zones and limit or eliminate pressure communication between them. The present applicants have found that, if this is not the case, an oscillatory system can be set up due to interactions between axially moving deformations on the tube and the pressure field within the injected fluid. Isolation of pressure zones allows the pressure profile to be set and maintained at a specified profile without "cross-talk" or interference between zones.

[0014] The pressure of the fluid layer between the sleeve inner surface and the tube will be substantially equal to the internal pressure in the tube less a component due to the elastic and viscous resistance of the tube wall.

[0015] In practice, the wall thickness of the tube being extruded will typically vary by ±10%, which will cause variation of a similar magnitude in the elastic and viscous resistance to the internal pressure. As the tube wall resists a large component, typically 60-90%, of the internal pressure, and the lubricating layer pressure is therefore only the remaining 10-40%, the 10% variation in resistance translates to about ±50% variation in the lubricating layer pressure.

[0016] The sizing apparatus preferably includes injection fluid flow rate stabilising means which substantially reduces variation in the rate of fluid injection caused by pressure variations of the lubricating layer. Preferably the fluid flow rate stabilising means causes a 50% variation in the lubricating layer pressure to result in less than 20%, preferably less than 10%, variation in the injection rate.

[0017] In one arrangement, the flow rate stabilising means can control the fluid supply to the injection apertures 16, for example comprising a flow control device 28 (see Fig. 2) placed in the fluid supply lines to each of the pressurised portions 10. The flow control device 28 may be high pressure drop constriction, such as an orifice, provided with substantial excess pressure at its upstream side so that normal variations in pressure at the downstream side have little effect on the flow rate through the device. For example, the pressure drop caused by the constriction device should be greater than the lubricating layer pressure.

[0018] In order to provide sufficient flow rate stability, the pressure provided by the fluid source is preferably at least 100% and most desirably at least 150% of the maximum internal pressure, at least in the pressurised portion adjacent the entry end of the sizing sleeve. At this point, the tube wall is in a plastic state and the elastic resistance to the internal pressure is at its lowest, but will still counteract a very significant proportion of the internal pressure and thus the fluid source pressure will be substantially greater than the lubricating layer pressure. As the tube progresses through the sizing sleeve, the outer surface of the tube is cooled by the fluid film and the thickness of the outer hardened portion of the tube progressively increases until the tube no longer requires diametral support from the film pressure to hold its diameter under the stress of the internal pressure. Thus, the fluid supply pressure can be reduced progressively along the sizing sleeve if desired.

[0019] Alternatively, the high pressure source and orifice may be substituted by a mechanical flow control device which adjusts to keep the flow rate relatively constant.

[0020] The drainage zones can be simply a gap 12 between adjacent pressurised sleeve portions, as shown in Fig. 1. Alternatively, the drainage zones can be part of a continuous sizing sleeve, as shown in Fig. 2. In this embodiment, the sizing sleeve is formed as a jacketed tube, the inner tube having a plurality of apertures or circumferential slots 26 therethrough.

[0021] The region between the inner and outer tubes is divided into a plurality of regions 20 by a series of radial walls 22, with each region having a spigot 24 or other means for connection of fluid supply/outlet tubes. The regions 20a to which a supply of fluid under pressure is connected act as pressurised portions as in Fig. 1, while those regions 20b to which fluid outlet tubes are connected act as collection manifolds and thus drainage zones.

[0022] This arrangement allows flexibility in function, as the relative length of the pressurised portions and drainage zones can be varied to suit process conditions, by changing the number and order of the regions connected to fluid supply or to outlet. For example, in Fig. 2 the pressurised portions 10 have a length consisting of two successive regions, followed by drainage zones of one region.

[0023] In the arrangement of Fig. 2 the apertures in each sizing sleeve portion are relatively large, for example at least 1mm per 100mm tube diameter or a circumferential slot 26 to present minimal pressure drop to the fluid injection and drainage. The pressure of the manifold is therefore approximately equal to the lubrication layer pressure. Each pressurised manifold is connected to the high pressure fluid source 17 via a flow stabilising means 28 as discussed above. It is preferred that each manifold is connected to the source 17 via a separate flow stabiliser 28, so that fluctuations in tube wall thickness will not cause one chamber to inject excessive water at the expense of the other chambers.

[0024] In an unillustrated modification of Fig. 2, the injection slots 26 or apertures can be divided into a number of circumferential sectors and the fluid supply

to each sector made independent by providing each with its own flow stabiliser. Alternatively, each sector can be provided with a separate fluid supply. This latter arrangement can be used to control fluid supply pressure to each part of the sleeve circumference independently. The applicant has determined that the eccentricity in the circularity and wall thickness of the tube approaching the sizing device is often caused by pin offset in the extruder head producing the tube. Such eccentricity is regular and predictable, and thus may be amenable to compensation by independent control of the injection fluid in the sizing device in a number, for example three to eight, of circumferential sectors.

[0025] An alternative means of attaining flow stability is to inject fluid through a large number of fine apertures, for example less than about 0.5mm and more preferably less than about 0.25mm in hydraulic diameter. For larger tube diameters e.g. over 100mm, flow stability may be achieved using apertures of hydraulic diameter less than 0.5% of the tube diameter. These fine apertures restrict the flow therethrough, maintaining the high pressure drop between the fluid supply and the lubricating fluid layer, so that flow through each hole is substantially independent and does not vary substantially even if the tube wall is spaced from the inner surface of the sizing sleeve in the vicinity of the hole due to local deformation or eccentricity in the tube. Thus, the use of high pressure drop injection apertures and a high pressure fluid source as the flow stabilising means has the advantage of stabilising the fluid injection about the sizing sleeve circumference as well as stability of the overall fluid flow into the sizing sleeve.

[0026] Figs. 3 to 5 illustrate a modular sizing sleeve construction according to a further embodiment, which facilitates the formation of fine injection apertures.

[0027] The sizing sleeve is formed of a series of segments 30 each integrally comprising an inner ring portion 32, a bridging portion 24 at one end, and an outer coaxial ring portion 36 with an inlet or outlet aperture 37.

[0028] The inner and outer ring portions are offset axially and radially from each other, so that the fitting segments together forms a substantially continuous sizing sleeve surface surrounded by a series of annular manifolds 38. Each manifold is sealed against external leakage by an o-ring 40 in a groove 42 in one segment contacting a surface of the next segment, and the segments are held in place by a clamping arrangement consisting of a pair of clamping rings 44, 46 joined by a series of tie bars 48. The upstream clamping ring 44 may have an inner surface 50 acting as a lead in portion for the sizing sleeve, having a rounded entry part 52 formed of polymer material such as high density polyethylene (HDPE).

[0029] The front end face of each inner ring portion abuts the bridging portion rear face 54 of the adjoining segment, and has a series of radial grooves 56 milled therein. When adjacent segments are joined together and the manifolds connected to a high pressure fluid supply these grooves serve as the injection apertures for injection of the fluid to the inside of the sizing sleeve.

[0030] An advantage of this construction is that the size and shape of the injection apertures can be carefully controlled because the manufacture involves cutting notches into an end surface of each segment rather than laser or physical drilling through the body of the sizing sleeve. Very fine apertures can be produced, for example triangular notches about 0.1 - 0.2mm deep and 0.1 - 0.3mm wide (see Fig. 5), by conventional machining techniques. Another advantage of this construction is the ability to dismantle and clean the sizing sleeve in the event of blockage of the injection apertures.

[0031] The very fine aperture size causes high pressure drop and allows independent flow through each aperture, as discussed previously. For example, a pressure drop across the apertures of 3-4 MPa can be achieved. This is in practice many times greater than the pressure of the lubricating fluid layer, which drives fluid exit at the drainage zones, and the inventors have found that it is highly desirable for the drainage apertures of each drainage zones to have a greater aperture area than the preceding pressurised zone. To achieve this, each segment to be used as a drainage zone may be spaced by a small amount, for example 0.2 - 2mm, from the previous segment by a spacing member such as a shim in order to create a circumferential drainage slot of that width. By way of example, the sizing sleeve may consist of twelve such segments and have each fourth segment spaced by 0.5mm to act as a drainage zone. Alternatively, special drainage segments can be provided, having a larger aperture area than the injection segments.

[0032] Figs. 6 to 7B illustrates an alternative modular sizing sleeve, which allows water to be injected at several places along the length of each segment. The arrangement is particularly adapted for use as the first pressurised portion of the sizing sleeve, where cooling and lubrication requirements are high, but if required this construction may be extended along the length of the sizing sleeve.

[0033] In this construction, the structure of the sizing sleeve is formed by a number of overlapping segments, each containing a fluid inlet or drainage connection 37. As seen from Fig. 7A, the second and subsequent segment 30b integrate the inner part 58, forming the inner surface of the sizing sleeve, with the outer part 60 which includes the fluid connection 37. The end surface 62 of the inner part is notched as described above for Figs. 4 to 6, to form injection or drainage apertures, and fluid passages 64 lead from the apertures 66 to the fluid connection 37.

[0034] The first segment 30a consists of an outer support ring 68 which mates with the second segment and has the fluid inlet 37, and a series of shorter inner rings 70 fitted inside to form the sizing sleeve inner surface. As seen in Figs. 7 and 8B, the inner rings have aligned bores 72 running therethrough at angularly spaced lo-

cations. The inner rings also have radial grooves 66 in their end surfaces and are chamfered at their outer edges so that, when adjacent rings are abutted together the adjacent chamfers form a circumferential fluid distribution channel 74 communicating with the radial channels formed by the grooves. The bore 72 through each ring 70 is flared to provide fluid communication with the circumferential channels and thus provide fluid to the injection apertures.

[0035] Fig. 8 illustrates an alternative entry arrangement for the sizing sleeve, incorporating an adjustable width fluid injection aperture.

[0036] The illustrated entry arrangement is fitted to a sizing sleeve comprising segments of the type designated by reference numeral 30b in Fig. 7A, but is suitable for use with sizing sleeves of other types. A forwardly facing channel ring 76 has a flange 78 extending inwards to align with the inner surface of the sizing sleeve, with an inwardly angled front surface 80 surrounding the sizing sleeve opening. The outer part of the channel incorporates the fluid inlet port 82 for providing water to the manifold 84 defined within the channel. The front of the channel is closed off by an externally threaded entry flange 86 which screws into engagement with a fine internal thread 88 on the outer part of the channel. The front surface of the entry flange includes a frustoconical lead in portion 90 which extends inwards to a diameter slightly smaller, for example up to 1mm or more preferably about 0.2mm, than that of the sizing sleeve inner surface. The smaller diameter lip functions as a seal with the plastic tube which bears against it with a high pressure. The contact surface 91 should preferably have a hard coating such as DLC (diamond-like coating).

[0037] The entry flange rear surface is parallel to the front surface 80 of the inwards flange 78 to create a circular fluid injection slot. This injects the lubricating water behind the overhanging lip of the lead in portion 90 to form a lubricating layer which is carried along by the travelling tube. The width of the slot 92, and therefore the amount of liquid injected as the lubricating layer, may be adjusted by screwing the threaded flange 86 in or out relative to the channel ring 76.

[0038] Fluid injected in a first portion of the sizing sleeve may be at a higher temperature than the fluid injected further downstream, so that the tube travel in the initial part of the sizing sleeve is lubricated without cooling the tube so that it more readily adopts the shape of the sizing sleeve. In the remainder of the sizing sleeve, the injection fluid both lubricates and cools the tube.

[0039] In further modifications, the pressure and/or temperature profiles along the length of the sizing device can be controlled by varying the temperature and pressure of the fluid injected at various points along its length. In this way, it is possible to exert fine control over the final diameter of the resultant tube. For example, each pressurised sizing sleeve portion may have a separate fluid source with independently controllable temperature and pressure.

[0040] Figs. 9 and 10 show a further embodiment of a modular sizing sleeve, in which each segment 94 consists of an inwards facing circumferential channel 96 with an outwards supporting flange 98. An array of the axial rods 100 pass through the support flanges 98 of the segments to hold them in an axially spaced formation.

[0041] Each channel ring includes a pair of hardened inner surfaces 102a, 102b serving as sizing sleeve surfaces for supporting the travelling tube 104, and has a fluid supply 106, and injection aperture 108 leading to the annular space 110 defined between the channel and the tube. The injection fluid is supplied under pressure to this annular space 110 to support the tube in this region. The water flow through the apertures 108 may be adjustable by means of a threaded adjustment member 112 as best seen in Fig. 10.

[0042] The space 114 between the adjacent segments forms the drainage zone of the sizing sleeve, with the relative proportions of the injection and drainage zones being adjustable by changing the spacing of the segments. As illustrated, the sizing sleeve solid surface area, surfaces 102a and 102b, may be approximately equal to the remaining area presented by the spaces 110 and 114. Furthermore, with open contact between the tube 104 and cooling water in a cooling bath (not shown) in which the sizing sleeve is situated, the temperature control may predominantly be carried out by the cooling water rather than the injection water and application of vacuum to the tube exterior in the drainage zones is easily achieved. Warm water may be injected to the first segments to assist the tube to adopt the sizing sleeve diameter.

[0043] In addition, as there is not interfitting of the segments, it is a simple matter to grade the inner diameter of successive segments down slightly to accommodate slight shrinkage of the tube by cooling as it passes through the sizing sleeve.

[0044] While particular embodiments of this invention have been described, it will be evident to those skilled in the art that the present invention may be embodied in other specific forms without departing from the essential characteristics thereof as defined in the appended claims. The present embodiments and examples are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

Claims

1. A sizing sleeve for controlling the outer diameter of an internally pressurised plastic tube (2) travelling through the sizing sleeve, the sizing sleeve having an upstream and a downstream end relative to the

tube travel, including at least two pressurised sizing sleeve portions each having means for injecting fluid under pressure substantially about the circumference of the tube (2) to form a lubricating fluid layer between a sizing sleeve inner surface and the tube (2), the pressurised! sizing sleeve portions are axially separated and isolated from each other by a drainage zone, **characterised in that** each pressurised sizing sleeve portion comprises an inner sizing sleeve member having a plurality of coaxial rings (30) arranged end-to-end and each having a plurality of injection apertures (56) extending thereacross, and an annular injection fluid manifold (38) radially surrounding the inner sizing sleeve member, receiving fluid from a fluid supply means and communicating with said injection apertures (56), the injection apertures (56) being formed between end surfaces (54) of adjacent rings, said injection apertures being formed by grooves in one or more of said end surfaces (54), and said grooves communicating with said fluid supply means and extending to the sizing sleeve inner surface.

2. The sizing sleeve according to claim 1, **characterised in that** said grooves (54) extend substantially radially across said end surface.

3. A sizing sleeve according to claim 1 or 2, **characterised in that** the injection apertures (56) cause a sufficiently high pressure differential between the manifold (38) and the lubricating fluid layer so that a 50% variation in pressure of the lubricating fluid layer causes less than 20% variation in the rate of fluid injection through said apertures (56).

4. A sizing sleeve according to claim 3, **characterised in that** pressure in said manifold (38) exceeds the internal pressure in said tube (2).

5. A sizing sleeve according to claim 4, **characterised in that** manifold pressure exceeds 150% of the internal pressure in said tube (2).

6. A sizing sleeve according to any one of claims 3 to 5, **characterised in that** said injection apertures (56) have a diameter less than 0.5 mm.

7. A sizing sleeve according to claim 6, **characterised in that** said injection apertures (56) have a diameter less than 0.25 mm.

8. A sizing sleeve according to any one of the preceding claims, **characterised in that** the sizing sleeve includes an entry portion (86) which projects radially inwards of said sizing sleeve inner surface.

9. A sizing sleeve according to claim 8, **characterised in that** it includes means (84) for injecting said fluid behind said inwardly projecting entry portion (86).

10. A sizing sleeve according to claim 9, **characterised in that** said injecting means includes a circumferential slot (92) located behind said entry portion (86).

11. A sizing sleeve according to claim 10, **characterised in that** it includes a screw connection (88) between said entry portion (86) and a manifold to adjust the area of said slot.

12. A sizing sleeve according to claim 8, **characterised in that** said entry portion (86) includes a hardened contact surface (91) having a diamond-like coating.

13. A sizing sleeve according to any one of the preceding claims, **characterised in that** the coaxial rings (30) are held in place by a clamping arrangement consisting of a pair of clamping rings (44, 46) joined by a series of tie bars (48).

Patentansprüche

1. Kalibriermuffe für die Kontrolle des äußeren Durchmessers eines im Innern unter Druck stehenden Plastikrohres (2), das sich durch die Kalibriermuffe hindurch fortbewegt, wobei die Kalibriermuffe ein aufwärts liegendes Ende und ein abwärts liegendes Ende in Bezug auf die Fortbewegung des Rohres besitzt, und mindestens zwei unter Druck stehenden Kalibriermuffeabschnitten enthält, wobei jeder Abschnitt ein Mittel besitzt zum Einspritzen eines Fluids unter Druck, im wesentlichen um den Umfang des Rohres (2) herum, um eine schmierende Fluidschicht zwischen einer inneren Oberfläche der Kalibriermuffe und dem Rohr (2) zu erzeugen, wobei die unter Druck stehenden Kalibriermuffeabschnitte mit Hilfe einer Drainagezone axial voneinander getrennt und isoliert sind, **dadurch gekennzeichnet, dass** jeder der unter Druck stehenden Kalibriermuffeabschnitte ein inneres Kalibriermuffeelement aufweist, welches Element eine Vielzahl von koaxialen Ringen (30) besitzt, die Ende gegen Ende angeordnet sind, und über eine Vielzahl von Einspritzöffnungen (56) verfügt, welche Einspritzöffnungen sich quer über die Ringen hinweg erstrecken, und dass ein ringförmiges Fluidverteilerrohr (38) aufweist, das das innere Kalibriermuffeelement radial umgibt und das Fluid von einem Fluidversorgungsmittel erhält und mit den Einspritzöffnungen (56) in Kommunikation steht, wobei diese Einspritzöffnungen (56) zwischen den Endflächen (54) von nebeneinander liegenden Ringen ausgebildet sind und aus Rillen in einer oder in mehreren der Endflächen (54) gebildet werden, und wobei diese Rillen in Verbindung stehen mit dem

Fluidversorgungsmittel und sich hin auf die innere Oberfläche der Kalibriermuffe erstrecken.

2. Kalibriermuffe nach Anspruch 1, **dadurch gekennzeichnet, dass** die Rillen (54) sich im wesentlichen radial über die Endoberfläche erstrecken.

3. Kalibriermuffe nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Einspritzöffnungen (56) einen ausreichend hohen Unterschied im Druck zwischen dem Fluidverteilerrohr (38) und der schmierenden Fluidschicht erzeugen, derart dass eine Druckveränderung von 50 % in der schmierenden Fluidschicht eine Veränderung von weniger als 20 % bei der Abflussmenge der Fluideinspritzung durch die Einspritzöffnungen (56) verursacht.

4. Kalibriermuffe nach Anspruch 3, **dadurch gekennzeichnet, dass** der Druck in dem Fluidverteilerrohr (38) den inneren Druck in dem Rohr (2) überschreitet.

5. Kalibriermuffe nach Anspruch 4, **dadurch gekennzeichnet, dass** der Druck in dem Fluidverteilerrohr den inneren Druck in dem Rohr (2) um 150 % überschreitet.

6. Kalibriermuffe nach irgendeinem der Ansprüche 3 oder 5, **dadurch gekennzeichnet, dass** die Einspritzöffnungen (56) einen Durchmesser von weniger als 0,5 mm haben.

7. Kalibriermuffe nach Anspruch 6, **dadurch gekennzeichnet, dass** die Einspritzöffnungen (56) einen Durchmesser von weniger als 0,25 mm haben.

8. Kalibriermuffe nach irgendeinem der vorgehenden Ansprüche, **dadurch gekennzeichnet, dass** die Kalibriermuffe einen Eintrittsabschnitt (86) aufweist, der sich an der inneren Fläche der Kalibriermuffe radial nach innen erstreckt.

9. Kalibriermuffe nach Anspruch 8, **dadurch gekennzeichnet, dass** sie Mittel (84) zum Einspritzen des Fluids hinter dem sich nach innen erstreckenden Eintrittsabschnitt (86) enthält.

10. Kalibriermuffe nach Anspruch 9, **dadurch gekennzeichnet, dass** die Einspritzmittel einen umlaufenden Schlitz (92) umfassen, der sich hinter dem Eintrittsabschnitt (86) befindet.

11. Kalibriermuffe nach Anspruch 10, **dadurch gekennzeichnet, dass** sie eine Schraubenverbindung (88) zwischen dem Eintrittsabschnitt (86) und einem Fluidverteilerrohr aufweist, um die Fläche des Schlitzes anzupassen.

12. Kalibriermuffe nach Anspruch 8, **dadurch gekennzeichnet, dass** der Eintrittsabschnitt (86) eine gehärtete Kontaktoberfläche (91) aufweist, die mit einer diamantähnlichen Beschichtung versehen ist.

13. Kalibriermuffe nach irgendeinem der vorgehenden Ansprüche, **dadurch gekennzeichnet, dass** die Koaxialringe (30) an ihrem Platz gehalten werden mit Hilfe einer Klemmvorrichtung, die aus einem Paar Klemmringen (44,45) besteht, die durch eine Reihe von Verbindungsstangen (48) miteinander verbunden sind.

Revendications

1. Manchon de calibrage pour régler le diamètre extérieur d'un tube de matière plastique (2) placé sous pression interne se déplaçant à travers le manchon de calibrage, le manchon de calibrage ayant une extrémité amont et une extrémité aval par rapport au déplacement du tube, comprenant au moins deux parties de manchon de calibrage sous pression ayant chacune des moyens pour injecter un fluide sous pression essentiellement autour de la circonférence du tube (2) pour former une couche de fluide lubrifiant entre une surface interne du manchon de calibrage et le tube (2), les parties de manchon de calibrage sous pression étant axialement séparées et isolées l'une de l'autre par une zone de drainage, **caractérisé en ce que** chaque partie de manchon de calibrage sous pression comprend un élément de manchon de calibrage interne ayant une pluralité d'anneaux coaxiaux (30) agencés bout à bout et ayant une pluralité d'ouvertures d'injection (56) s'étendant en travers, et un collecteur annulaire de fluide d'injection (38) entourant radialement l'élément de manchon de calibrage interne, recevant du fluide d'un moyen d'alimentation en fluide et communiquant avec lesdites ouvertures d'injection (56), les ouvertures d'injection (56) étant formées entre des surfaces d'extrémité (54) d'anneaux adjacents, lesdites ouvertures d'injection étant formées par des rainures dans une ou plus desdites surfaces d'extrémité (54), et lesdites rainures communiquant avec ledit moyen d'alimentation en fluide et s'étendant vers la surface interne du manchon de calibrage.

2. Manchon de calibrage selon la revendication 1, **caractérisé en ce que** lesdites rainures (54) s'étendent sensiblement radialement en travers de ladite surface d'extrémité.

3. Manchon de calibrage selon la revendication 1 ou 2, **caractérisé en ce que** les ouvertures d'injection (56) provoquent une différence de pression suffisamment élevée entre le collecteur (38) et la cou-

che de fluide lubrifiant de sorte qu'une variation de 50% de la pression de la couche de fluide lubrifiant provoque moins de 20% de variation du débit d'injection de fluide à travers lesdites ouvertures (56).

4. Manchon de calibrage selon la revendication 3, **caractérisé en ce que** la pression dans ledit collecteur (38) dépasse la pression interne dans ledit tube (2).

5. Manchon de calibrage selon la revendication 4, **caractérisé en ce que** la pression du collecteur dépasse 150% de la pression interne dans ledit tube (2).

6. Manchon de calibrage selon l'une quelconque de revendications 3 à 5, **caractérisé en ce que** lesdites ouvertures d'injection (56) ont un diamètre inférieur à 0,5 mm.

7. Manchon de calibrage selon la revendication 6, **caractérisé en ce que** lesdites ouvertures d'injection (56) ont un diamètre inférieur à 0,25 mm.

8. Manchon de calibrage selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le manchon de calibrage comprend une zone d'entrée (86) qui fait saillie radialement vers l'intérieur de ladite surface interne du manchon de calibrage.

9. Manchon de calibrage selon la revendication 8, **caractérisé en ce qu'**il comprend un moyen (84) pour injecter ledit fluide derrière ladite zone d'entrée (86) faisant saillie vers l'intérieur.

10. Manchon de calibrage selon la revendication 9, **caractérisé en ce que** ledit moyen d'injection comprend une fente périphérique (92) située derrière ladite zone d'entrée (86).

11. Manchon de calibrage selon la revendication 10, **caractérisé en ce qu'**il comprend une connexion à vis (88) entre ladite zone d'entrée (86) et un collecteur pour ajuster la surface de ladite fente.

12. Manchon de calibrage selon la revendication 8, **caractérisé en ce que** ladite zone d'entrée (86) comprend une surface de contact durcie (91) ayant un revêtement de type diamanté.

13. Manchon de calibrage selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les anneaux coaxiaux (30) sont maintenus en place par un aménagement de serrage constitué d'une paire d'anneaux de serrage (44, 46) joints par une série de barres d'accouplement (48).

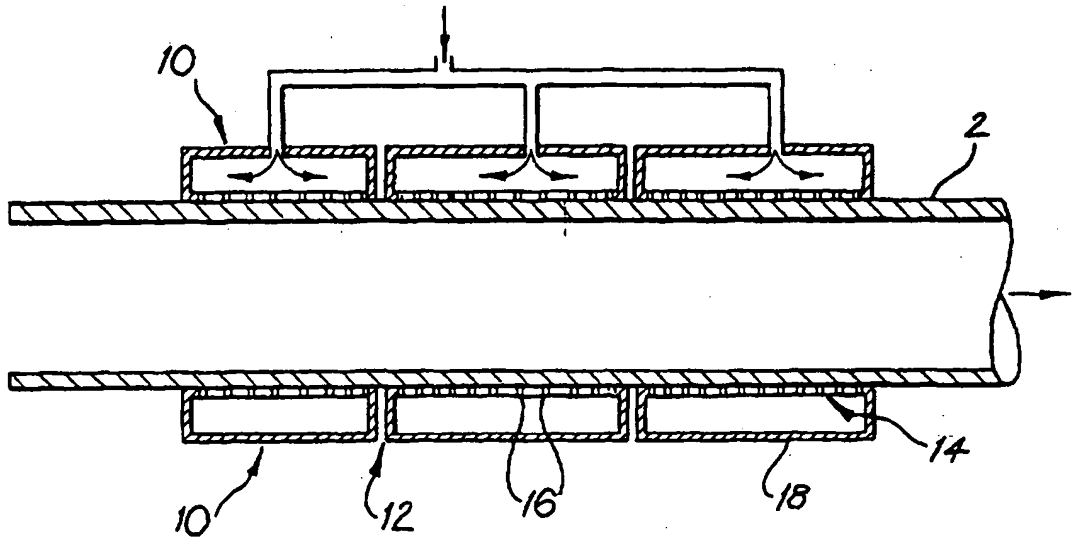

FIG. 1

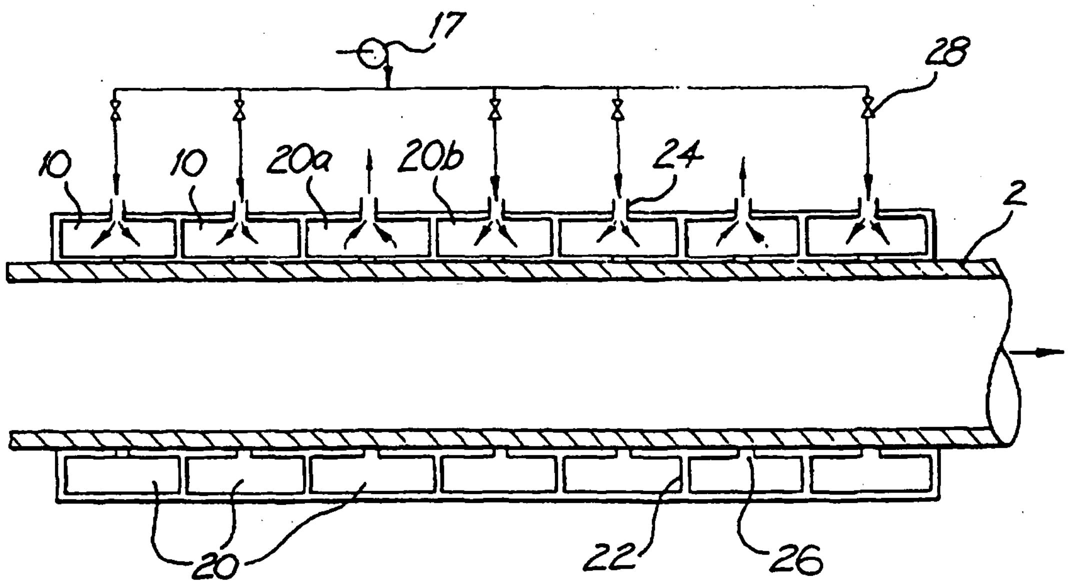

FIG. 2

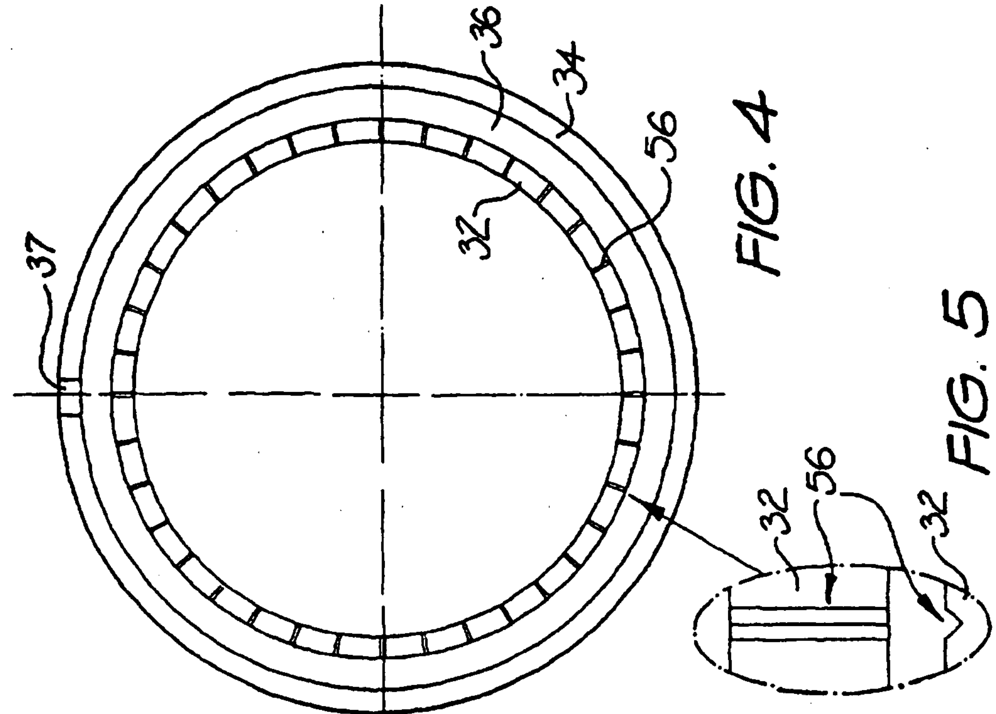

FIG. 4

FIG. 5

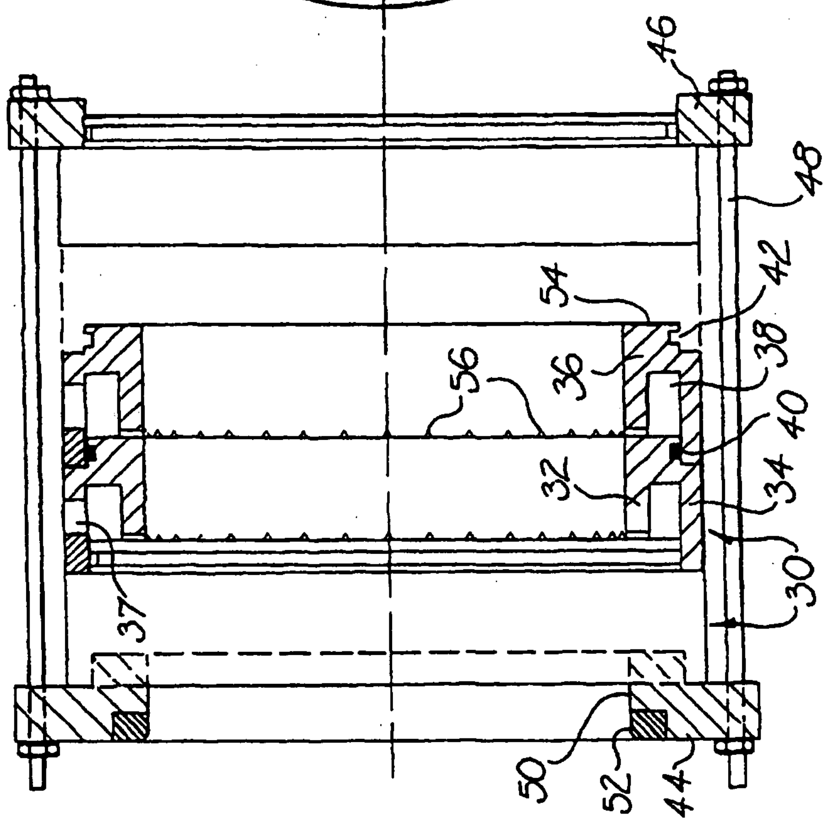

FIG. 3

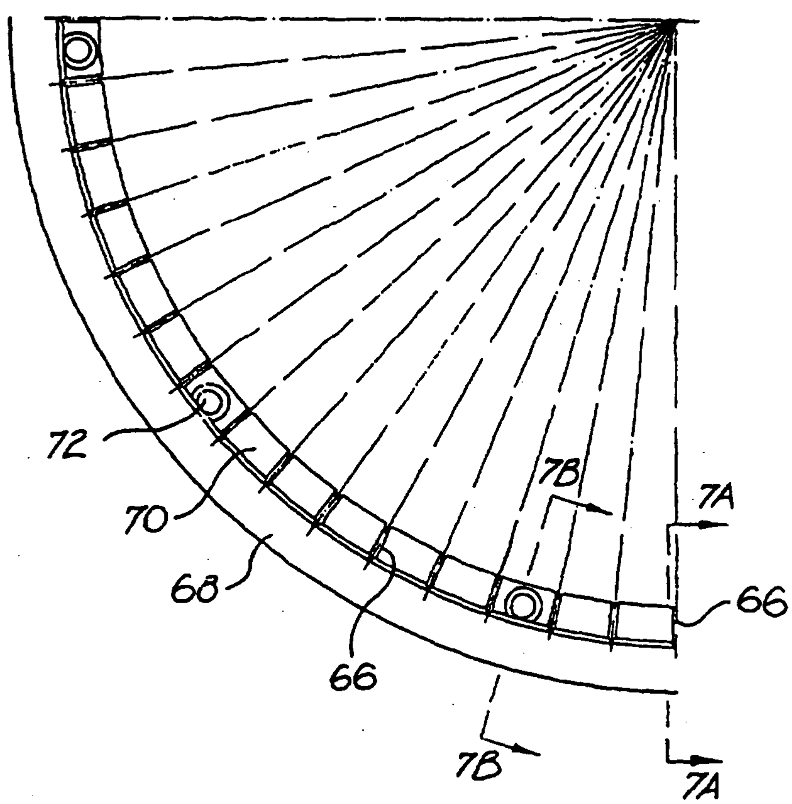

FIG. 6

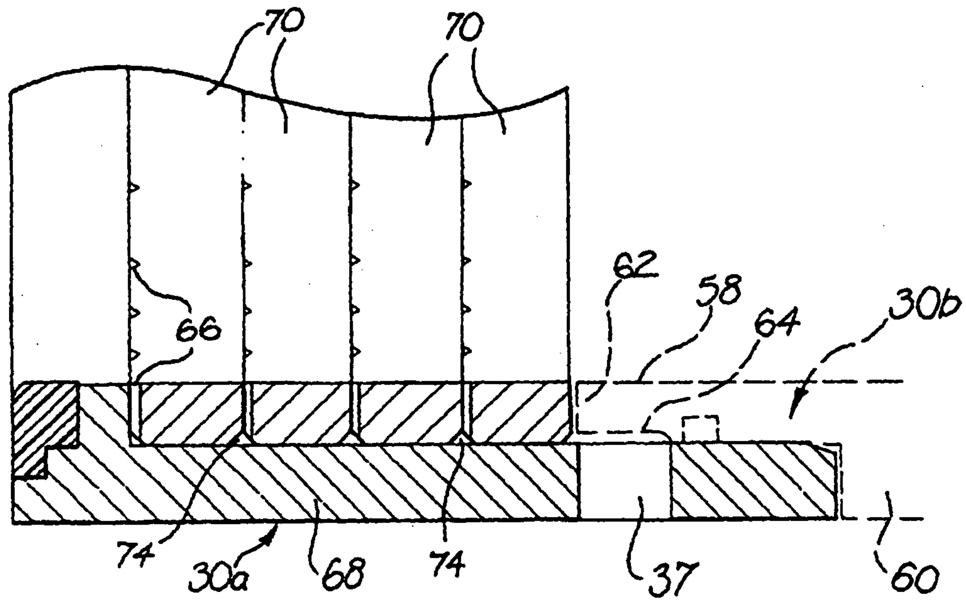

FIG. 7A

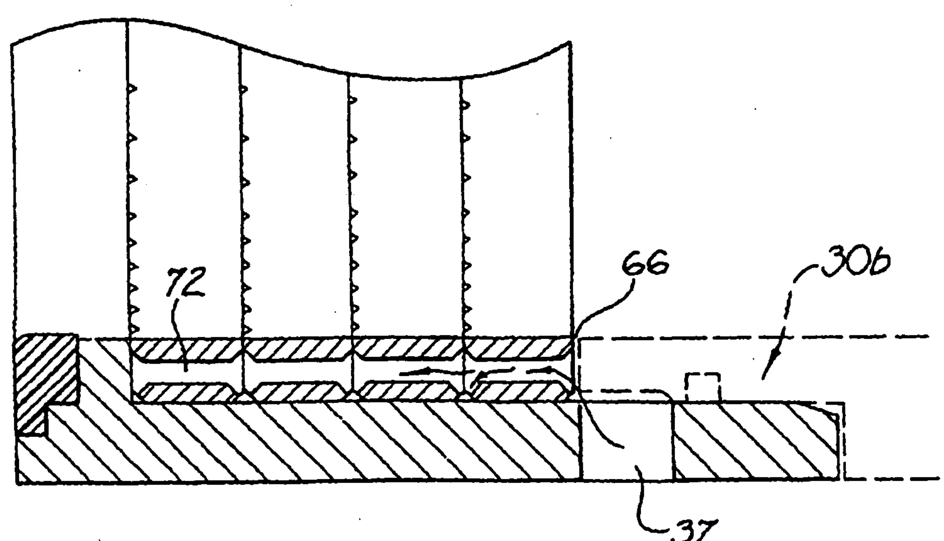

FIG. 7B

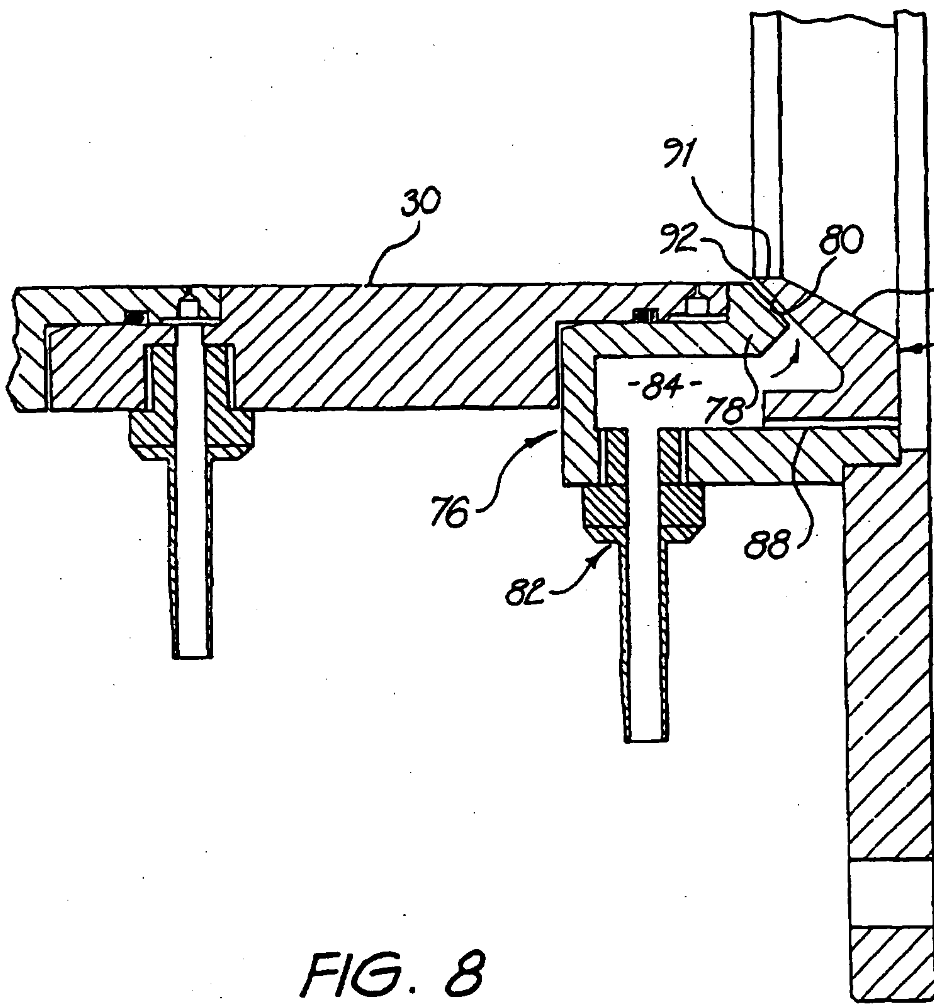

FIG. 8

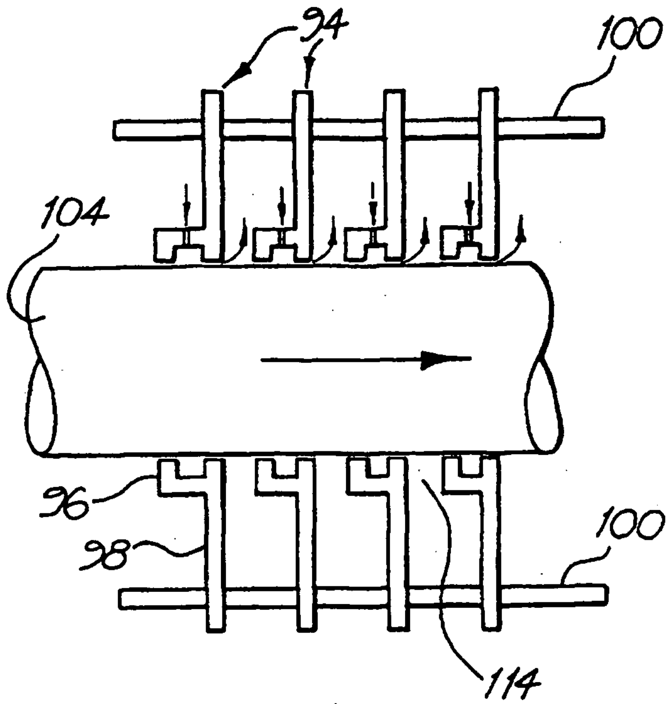

FIG. 9

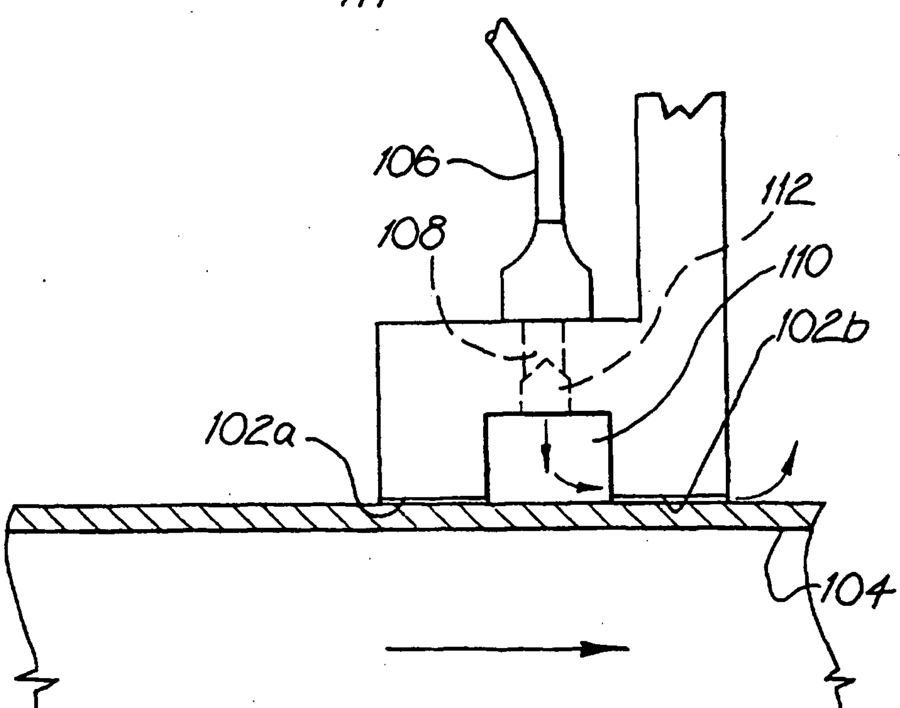

FIG. 10